Apparatus for Use in an Industrial Process and Plant including such Apparatuses as well as Method for Simulating Operation of such a Plant

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Background of the Invention

The invention relates to an apparatus for use in an industrial process in which for communicating data and control signals it is connectable to a central control unit via a bus. The invention relates furthermore to a plant including such apparatuses as well as to a method for simulating such a plant.

Nowadays, complex processes and process sequences, e.g. in operating a large industrial plant are automated. Usually, in any such plant very many apparatuses, for instance sensors, actors, valves, pumps and the like are connected via a bus to a central control unit (PC or process control system) which controls the apparatuses. In this respect one point essential for the safety and reliable functioning of the plant is the behaviour of each and every apparatus and how each interacts with the other. It is currently usual to prepare a specification for each apparatus, which is loaded into the central control unit to inform it as to the functionality and parameters of the apparatus. However, this specification is incomplete and not suitable to provide the central control unit with a comprehensive mimic image of the apparatus concerned. Plants in which apparatuses are used for which these incomplete apparatus specifications exist as loaded into the central control unit can thus be tested only on-line and also the overall behaviour of the plant resulting from how the individual apparatuses interact can only be tested and analyzed with the apparatuses on-line.

Summary of the Invention

The invention is based on the object of providing an apparatus of the aforementioned kind which is equipped so that it enables the central control unit to simulate operation of the apparatus as if it really were on-line with the central control unit via the bus. Furthermore, it is intended to provide a plant with such apparatuses, the overall behaviour of which can be simulated in the central control unit. It is still a further intention to provide a method for simulating such a plant.

The apparatus in accordance with the invention is characterized in that in the apparatus a software apparatus model is memorized which contains a comprehensive mimic image of the apparatus including its parameters, functionality and sequence programs.

The plant in accordance with the invention is characterized in that the apparatus models are loadable into the control unit, that in the control unit a software program is provided with the aid of which in using the loaded apparatus models the operation of the plant can be simulated for testing it in including all parameters and functionalities contained in the apparatus models.

The method in accordance with the invention is characterized by it comprising the steps of loading apparatus models of the apparatuses to be employed in the plant into the central control unit and simulating the operation of the plant in including all parameters and functionalities contained in the apparatus models by means of a software program sequenced in the control unit.

Brief Description of the Drawings

The invention will now be explained by way of an example with respect to the drawing in which:

Fig. 1 is a schematic diagram illustrating a plant including apparatuses in accordance with the invention,

Fig. 2 is a schematic diagram illustrating a measuring apparatus including its essential elements and

Fig. 3 is an illustration of one example application of the invention.

Detailed Description of the Invention

Referring now to Fig. 1 there is illustrated the plant comprising, for example, three apparatuses 10, 12 and 14 connected to a central control unit 18 via a bus 16. The apparatuses involved may be sensors, actors, valves, pumps, etc. Memorized in each apparatus 10, 12, 14 is an apparatus model 20, 22 and 24 resp. containing all information relevant to the apparatus, i.e. all parameters, apparatus functionality as well as the programs and sequence specification contained in the apparatus. Each apparatus model is thus a comprehensive mimic image of the apparatus so that when making use of a corresponding software program, work can be done with the apparatus model just the same as with the real apparatus.

The apparatus models can be loaded into the central control unit 18, this being indicated by 20′, 22′ and 24′.

Referring now to Fig. 2 there is illustrated schematically a measuring apparatus 26, including its essential units, equipped with an apparatus model. This measuring apparatus receives at an input stage 30 a measurement signal which is processed in a processor 32 in taking into account input parameters and limit values to then output via an output stage 34 digital data to the bus 16 for communication to the central control unit 18 or also generates an output signal which directly activates a relay. The apparatus model 28 memorized in the measuring apparatus 26 can be loaded into the central control unit 18 which then specifies a dedicated measurement signal profile and simulates the behaviour of the measuring apparatus 26 on the basis of the apparatus model 28, it thereby simulating the total sequence from measurement signal receival via processing of the measurement signal up to output of the measured value and/or signalling a relay. Processing the measurement signal is specified by the parameters and the functionalities. In regular operation of the measuring apparatus processing the measurement signal is done, of course, with respect to the parameters and functionalities in the processor thereof by programs and/or sequence definitions being processed.

When several such apparatuses including apparatus models memorized therein and the corresponding software program are put to use in the central control unit 18 a total plant can be conceived and its behaviour simulated. How the many different apparatuses react to each other in this arrangement may also be simulated in particular, thus making it possible to mimic procedurally highly critical situations in the process, and the settings and operability of all apparatuses as well as their satisfactory interaction can be tested.

Referring now to Fig. 3 there is illustrated schematically an application indicating it is also possible to considerably shorten iterative processes in setting the measuring apparatuses, an example of which is a vessel 36 to be filled at the top by means of a pump 38 and emptied at the bottom via a discharge closed off by means of an adjustable valve, a measuring apparatus 42 dictating the material level in the vessel 36. From the simulation by means of the apparatus model memorized in the measuring apparatus 42 and loadable into the control unit 18 it can be recognized directly whether the pump 36, for example, supplies more material than is discharged via the valve 40 so that the valve needs to be opened already at a lower material level. When this problem is "seen" in simulation and all relevant variables have been defined, the dimensioning thereof can be undertaken for the desired correct behaviour.

The apparatus models 20, 22, 24, 28 may also be used for simulation as independent simulation modules, e.g. held in a data base, it, of course, also being possible to memorize these apparatus models on data carriers which are loaded into the central control unit 18 from the data carrier.

Preferably, however, the apparatus models are held in the corresponding apparatuses and the connection to the central control unit is made via the bidirectional bus, the central control unit then acting like a simulation processor as influenced by the corresponding software program in simulation.

Should it turn out in simulation that the parameters contained in the apparatus model are unfavorable, they can be changed in the central control, the correspondingly changed apparatus model being then memorized in the apparatus. In this

arrangement, the changes to the apparatus model may relate not only to changes in the parameters but also to the software existing in each apparatus.

The invention now makes it possible to conceive and test industrial systems by simple ways and means without it being necessary to run the apparatuses on-line which are usually large in number.